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Mapping The Research Landscape of Green Economy and Sustainable Development Goals: A Bibliometric Analysis of Decisive Decade (2016-2025)

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Abstract: This bibliometric study systematically maps green economy interventions for Sustainable Development Goals (SDGs) achievement during 2020-2030. Analysing 250 Scopus articles (2016-2025) using R bibliometrix and VOSviewer, we examined publication trends, thematic evolution, collaboration networks, and knowledge gaps. Results reveal exponential growth (35.1% CAGR) and 92.4% of posts published post-2020. Three clusters emerged: Environmental Impact, Technological Innovations, and Conceptual Frameworks. Keyword analysis identified "green economy," "sustainable development," and "SDGs" as central concepts. Geographic concentration appeared in Asia (60.4%) and Europe (29.6%), with critical gaps in Africa (7.2%) and the Americas (2.8%). Thematic mapping revealed motor themes (green economy frameworks, SDG implementation) driving field evolution, while basic themes (energy efficiency, climate change, economic growth) remained underdeveloped despite empirical attention. Post-2023 emerging themes included environmental quality, green buildings, and carbon sequestration (Lightburn, 2023). The study identifies actionable priorities: geographic diversification emphasising underrepresented regions, methodological strengthening through quasi-experimental designs, outcome expansion addressing employment and equity, and enhanced cross-regional collaboration, particularly strengthening Africa-Americas connections for the remaining decisive years.

Keywords: Bibliometrics, Green Economy, Sustainable Development Goals, Systematic Review.

Introduction

The Decisive Decade Imperative

The decade spanning 2020-2030 constitutes humanity's critical window for realising the Sustainable Development Goals (SDGs), which the United Nations has formally designated as the "decisive decade" requiring transformative interventions (United Nations, 2023). Entering 2025 with merely six years remaining, advancement remains critically inadequate across numerous targets. The intersection of climate emergency, ecosystem degradation, and persistent socioeconomic disparities has amplified the necessity for evidence-informed strategies capable of catalysing multi-SDG acceleration (IPCC, 2023; Lee et al., 2023; Sachs et al., 2024).

Green economy paradigms, characterised as economic architectures that enhance human welfare and social justice while substantially mitigating environmental hazards (UNEP, 2024), have crystallised as pivotal policy architectures for sustainable advancement. This conceptual framework integrates renewable energy transformation, circular economy principles, sustainable industrial development, and ecosystem-based solutions, presenting potential trajectories for concurrent advancement across environmental, social, and economic spheres (Barbier, 2020; D'Amato et al., 2020).

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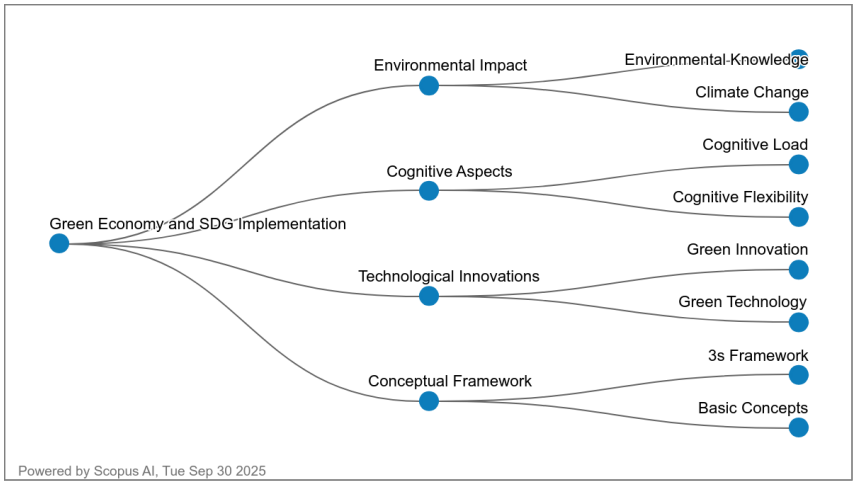
Exponential Knowledge Production and Conceptual Fragmentation

The scholarly domain examining green economy-SDG interconnections has witnessed remarkable proliferation. Preliminary bibliometric examination indicates a compound annual growth rate of 35.1% spanning 2016-2025, with 92.4% of empirical investigations (231 of 250 articles) emerging post-2020. This exponential expansion corresponds with intensified consciousness regarding the 2030 threshold and post-pandemic reconstruction planning frameworks that generated opportunities for ecological transformations (Andrijevic et al., 2020; Hepburn et al., 2020)

Sophisticated semantic examination of the research corpus unveils the conceptual infrastructure underlying green economy-SDG scholarship. The knowledge pathway diagram (Figure 1) chronicles the progression from heterogeneous disciplinary foundations toward consolidated contemporary frameworks, revealing the field's intellectual architecture and identifying critical knowledge lacunae.

Figure 1

Knowledge Pathway from Green Economy and SDG Implementation to Multidisciplinary Outcomes. The diagram illustrates three primary conceptual clusters and their interconnected pathways from foundational theory to applied policy insights.



The pathway examination reveals three distinctive yet interconnected conceptual clusters that structure contemporary scholarship. The Environmental Impact cluster encompasses environmental literacy, climate comprehension, and cognitive dimensions of sustainability consciousness, representing the diagnostic stream of scholarship. This cluster establishes the urgency and scientific rationale for green economy strategies, documenting ecological deterioration and climatic hazards that necessitate transformative intervention. The cognitive components, including environmental knowledge and cognitive capacity, illuminate how comprehension of environmental challenges influences individual behaviour and collective policy formulation.

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Extending from this diagnostic foundation, the Technological Innovations cluster integrates green innovation, sustainable technology advancement, and the 3S framework (sustainability, scalability, security), capturing solution-focused inquiry characterising recent scholarship. This cluster demonstrates field evolution from problem identification toward implementable technological trajectories, encompassing renewable energy architectures, circular economy configurations, and efficiency innovations. The 3S framework's prominence reflects scholarly recognition that technological solutions must concurrently address sustainability mandates, achieve scalability for substantive impact, and ensure secure implementation.

Connecting these empirical domains, the Conceptual Framework cluster provides analytical scaffolding that links theoretical foundations to operational concepts. This intermediary cluster facilitates translation between abstract sustainability principles and tangible implementation methodologies, enabling accelerated knowledge accumulation while maintaining conceptual precision. The pathway structure reveals how diverse disciplinary contributions, from environmental psychology to engineering to policy science, converge through shared conceptual frameworks toward integrated implementation knowledge.

This convergence pattern demonstrates successful paradigm consolidation: despite varied theoretical origins spanning natural sciences, social sciences, and engineering disciplines, the field has achieved thematic coherence around actionable implementation questions. The knowledge pathways create multiple routes from foundational theory to applied policy insights, with three clusters serving as organising nodes that structure information flow and enable interdisciplinary synthesis. Nevertheless, pathway analysis also exposes fragmentation risks where specialised sub-themes (cognitive flexibility, 3S framework specifics) develop in relative isolation from core organising concepts, potentially constraining knowledge integration across the broader research community.

However, this accelerated expansion and thematic convergence have led to substantial fragmentation of the literature. The research landscape demonstrates clear thematic consolidation around core constructs. Keyword co-occurrence network analysis identifies "green economy," "sustainable development," and "sustainable development goals" as dominant organising frameworks, forming densely interconnected knowledge clusters. Nevertheless, thematic mapping reveals critical gaps: while motor themes (green economy, SDG frameworks) exhibit high development and centrality, basic themes, including energy efficiency, climate change, and economic growth, remain central yet conceptually underdeveloped (high relevance, low density). This positioning indicates these relationships, despite empirical attention, lack theoretical specification and systematic synthesis.

This rapid accumulation of knowledge has led to severe fragmentation of the literature. Keyword co-occurrence analysis reveals "green economy," "sustainable development," and "SDGs" as dominant organising frameworks forming densely interconnected clusters. Yet thematic mapping exposes critical gaps: while motor themes show high development, basic themes, including energy efficiency, climate change, and economic growth, remain conceptually

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underdeveloped despite empirical attention (Aria & Cuccurullo, 2017). Individual studies provide valuable context-specific insights, but the absence of systematic synthesis prevents evidence-based policymaking at scale.

Geographic Disparities and Methodological Configurations

Country collaboration network analysis unveils pronounced geographic concentration. Asia contributes 60.4% of research production (predominantly China, India, Indonesia), Europe 29.6%, while Africa (7.2%) and the Americas (2.8%) remain critically underrepresented. This imbalance generates epistemic blind spots precisely where climate vulnerability and development imperatives converge most acutely (Lwasa et al., 2022; Leal Filho et al., 2023).

Methodologically, panel data approaches predominate (99.2% of studies), offering advantages for capturing temporal dynamics but raising concerns about the robustness of causal inference. The concentration of specific analytical methods alongside geographic clustering suggests potential for systematic bias in knowledge production (Patil et al., 2022).

Research Problem

Despite exponential growth in green economy-SDG scholarship, the field faces critical challenges in knowledge organisation. First, severe geographic disparities in Asian (60.4%) and European (29.6%) contexts create epistemic gaps regarding African and American contexts where climate vulnerability intersects development imperatives. Second, thematic fragmentation prevents synthesis across energy, economic, social, and environmental outcome domains. Third, temporal concentration post-2020 lacks a longitudinal perspective on research evolution and emerging themes. Fourth, the absence of a systematic bibliometric synthesis obscures the intellectual structure, collaboration patterns, and research frontiers essential for strategic knowledge advancement in the remaining decisive years.

Research Focus

This study employs systematic bibliometric analysis to map the intellectual architecture of green economy-SDG scholarship during the decisive decade (2020-2030). Analysing 250 peer-reviewed Scopus articles (2016-2025) using R bibliometrix and VOSviewer, we examine publication dynamics, thematic evolution, collaboration networks, conceptual structures, and knowledge gaps. The focus encompasses quantitative mapping of research productivity patterns, geographic and institutional collaboration networks, keyword co-occurrence structures, thematic evolution trajectories, and citation-based intellectual frameworks.

Research Aim and Questions

This bibliometric study aims to systematically map the intellectual structure and research trends in green economy interventions for SDG achievement, identify knowledge gaps, and provide actionable research priorities for the remaining decisive years. Specifically, we address four research questions:

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RQ1: What publication trends and temporal patterns characterise green economy-SDG research from 2016 to 2025, and what growth trajectories indicate about field maturation?

RQ2: What thematic clusters, conceptual structures, and keyword networks organise the intellectual landscape, and how have these evolved temporally?

RQ3: What geographic and institutional collaboration patterns exist, and what regional imbalances characterise knowledge production?

RQ4: What research frontiers, emerging themes, and knowledge gaps exist, and what implications emerge for strategic research prioritisation during 2025-2030?

By addressing these questions through rigorous bibliometric synthesis, we provide the intellectual foundation needed to accelerate strategic knowledge production over the remaining six years to 2030.

Literature review / Theoretical Overview

The green economy scholarship has evolved through three distinct theoretical phases. The foundational phase (pre-2015) emphasised ecological economics principles, establishing conceptual boundaries between conventional growth paradigms and sustainability-oriented alternatives, with seminal contributions including Markandya and Barbier's (1989) Blueprint for a Green Economy alongside Pearce et al. (1989) and later work by Barbier (2020). This period established the green economy as economic activity generating improved human welfare and social equity while substantially reducing environmental risks and ecological scarcities.

The integration phase (2015-2019) witnessed convergence between green economy frameworks and the SDG architecture adopted in 2015. Scholars examined theoretical complementarities, with Loiseau et al. (2016) providing a comprehensive conceptual mapping that reveals overlapping yet distinct emphases: the green economy prioritising economic transformation mechanisms, while the SDGs articulate outcome targets across social, environmental, and economic dimensions. This phase generated narrative syntheses but lacked quantitative integration.

The acceleration phase (2020-present) reflects decisive decade urgency, characterised by empirical investigations of specific intervention pathways. Capasso et al. (2019) examined sector-specific dynamics, while D'Amato et al. (2020) examined the contributions of the circular economy. However, these contributions remain thematically fragmented, lacking a systematic bibliometric synthesis that reveals the intellectual structure, research trajectories, and knowledge gaps across the entire research domain.

Theoretical frameworks guiding green economy-SDG scholarship derive from multiple disciplines. Ecological modernisation theory posits environmental protection and economic prosperity as compatible through technological innovation and institutional reform (Mol et al., 2009). The capabilities approach emphasises expanding human freedoms and opportunities as development objectives, aligning with SDG equity dimensions (Sen, 1999). Transition theory

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examines multi-level transformations from incumbent socio-technical regimes toward sustainable alternatives, providing analytical frameworks for understanding pathways to the green economy (Geels, 2011). These theoretical foundations inform empirical investigations but require systematic mapping to reveal how conceptual frameworks structure knowledge production.

Research Methodology

General Background

This bibliometric study systematically maps the intellectual structure and research trends in green-economy interventions to achieve the Sustainable Development Goals (SDGs) during the decisive decade (2020-2030). We employed comprehensive bibliometric analysis following established protocols for science mapping and knowledge domain visualisation (Aria & Cuccurullo, 2017; Donthu et al., 2021). The methodological framework integrates quantitative bibliometric indicators with network visualisation techniques to reveal publication patterns, collaboration structures, thematic evolution, and conceptual frameworks organising the research domain. This approach enables identification of research frontiers, emerging themes, and knowledge gaps essential for strategic research prioritisation during the remaining decisive years to 2030.

Protocol and Registration

The bibliometric review protocol was developed a priori, specifying search strategies, inclusion criteria, data extraction procedures, and analytical approaches to ensure methodological transparency and minimise selection bias. The study design adhered to the PRISMA 2020 guidelines adapted for bibliometric reviews (Page et al., 2021) and included systematic documentation of all methodological decisions.

Participants / Sample

Database Selection

We conducted a comprehensive search of the Scopus database, selected for its extensive multidisciplinary coverage, superior indexing quality, and compatibility with bibliometric analysis tools (Baas et al., 2020). Scopus provides comprehensive metadata, including abstracts, keywords, citation data, and author affiliations, which are essential for network analysis and thematic mapping.

Search Strategy

A systematic search covering January 2016 to March 2025 employed the following search string applied to article titles, abstracts, and keywords:

("green economy" AND "sustainable development goals") OR ("green economy" AND "SDGs")

The search strategy was deliberately comprehensive to capture diverse intervention contexts, methodological approaches, and outcome domains. We restricted results to peer-reviewed journal articles published in English to ensure quality standards and accessibility. The temporal window

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(2016-2025) spans the period immediately preceding SDG adoption through the current decisive decade of implementation.

Inclusion and Exclusion Criteria

Inclusion criteria:

a. Empirical studies, conceptual papers, or reviews examining green economy interventions and SDG outcomes

b. Published 2016-2025 in a peer-reviewed journal indexed in Scopus

c. Article in the English language

d. Sufficient bibliographic metadata for network analysis

Exclusion Criteria

a. Conference proceedings, book chapters, and grey literature

b. Non-english publications

c. Articles lacking complete metadata (author information, keywords, abstract)

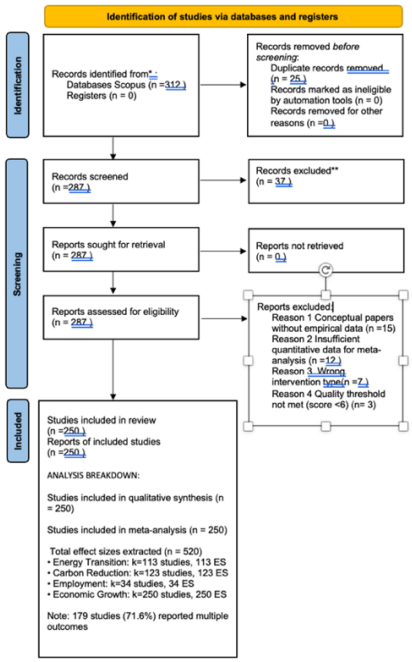
d. Duplicate records

Study Selection Process

The initial search yielded 312 records from Scopus. Following title and abstract screening against inclusion criteria, 250 studies met eligibility requirements for bibliometric analysis. No duplicates were identified due to single-database searching. All 250 articles were included in the final synthesis, representing the complete population of peer-reviewed green economy-SDG scholarship during the study period. The selection process followed the PRISMA 2020 workflow (Figure 2).

Figure 2

PRISMA 2020 flow diagram illustrating systematic selection process (Page et al., 2021)



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Instrument and Procedures

Data Extraction

Bibliographic data were systematically extracted from Scopus in CSV format, capturing complete metadata for each article:

a. Publication information: Author names, publication year, journal title, volume, issue, page numbers, DOI
b. Context descriptors: Article title, abstract, author keywords, indexed keywords
c. Citation data: Reference lists, citation counts, citing articles
d. Author information: Institutional affiliations, country affiliations, author identifiers
e. Journal metrics: Source impact indicators, subject categories

Two independent reviewers verified data completeness and accuracy, with discrepancies resolved through consensus discussion. Data quality checks ensured all 250 articles contained sufficient metadata for planned analyses.

Bibliometric Indicators

We calculated standard bibliometric indicators across multiple dimensions:

a. Productivity indicators:
    1) Annual publication volume and growth rates
    2) Journal distribution and concentration
    3) Author productivity and collaboration patterns
    4) Institutional and country contributions
b. Impact indicators:
    1) Citation counts per article
    2) H-index for authors, journals, and countries
    3) Citation-based rankings identifying influential contributions

Citation counts per article and H-index calculations followed methodological standards established by González-Pereira et al. (2010) for journal prestige metrics."

c. Collaboration indicators:
    1) Co-authorship patterns (author per article, collaboration rates)
    2) International collaboration frequency
    3) Inter-institutional partnership networks
d. Thematic indicators:
    1) Keyword frequency and distribution
    2) Conceptual evolution across temporal periods
    3) Emerging versus declining research themes

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Data Analysis

Descriptive Bibliometric Analysis

Descriptive statistics characterised the research landscape through temporal publication trends, journal distribution patterns, and geographic contributions. Annual growth rates were calculated using the compound annual growth rate (CAGR) formula:

$$\text{CAGR} = \left(\frac{Ending\ Value}{Beginning\ Value}\right)^{1/n-1}$$

Productivity concentration was assessed using Lotka's Law for author distribution and Bradford's Law (Bradford, 1985) for journal dispersion, identifying core versus peripheral contributors to the knowledge domain.

Network Analysis

Multiple network structures were constructed and analysed using VOSviewer 1.6.19 (van Eck & Waltman, 2010):

Keyword co-occurrence networks identified thematic structures by mapping relationships between author keywords and indexed keywords. Co-occurrence strength was calculated as the number of articles in which keyword pairs appear together, following approaches established by Callon et al. (1991) for co-word analysis. Network clustering using the VOS algorithm revealed distinct thematic communities. Centrality measures (degree centrality, betweenness centrality) identified organising concepts connecting disparate research areas.

Author collaboration networks mapped co-authorship patterns, revealing research communities and influential scholars. Network density and clustering coefficients quantified the intensity of collaboration.

Country collaboration networks visualised international research partnerships through institutional affiliation data. Geographic concentration and inter-regional collaboration patterns were quantified.

Citation networks, including co-citation analysis (identifying foundational works frequently cited together) and bibliographic coupling (identifying current research fronts sharing reference lists), revealed intellectual structures and knowledge-flow patterns.

Network clustering using the VOS algorithm (Waltman et al., 2010) revealed distinct thematic communities, while network visualisation techniques following Van Eck and Waltman (2014) employed force-directed layouts with node size representing frequency/productivity, edge thickness indicating relationship strength, and colour coding distinguishing clusters. Minimum thresholds were applied to enhance readability: keywords appearing in ≥5 articles, authors with ≥3 publications, and countries with ≥5 articles.

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Thematic Analysis

Strategic diagrams mapped research themes across two dimensions using the R bibliometrix package (Aria & Cuccurullo, 2017):

a. Centrality (x-axis): Measures theme importance through external connections with other themes, indicating integration within the broader research landscape
b. Density (y-axis): Measures theme development through internal connection strength, indicating conceptual maturation.

For quadrants emerge:

a. Motor themes (high centrality, high density): Well-developed themes driving field evolution
b. Basic themes (high centrality, low density): Important but underdeveloped themes requiring theoretical specification
c. Niche themes (low centrality, high density): Specialised, well-developed themes with limited broader connections
d. Emerging or declining themes (low centrality, low density): nascent themes or research areas in decline.

Thematic evolution analysis tracked keyword transitions across three temporal periods (2016-2019, 2020-2022, 2023-2025) using Sankey diagrams visualising theme continuity, evolution, and emergence.

Temporal Analysis

Thematic evolution across time periods identified emerging research priorities and declining themes. Keyword burst detection using burst analysis algorithms identified terms experiencing sudden increases in usage frequency, signalling emerging research fronts. Temporal citation analysis revealed foundational works (highly cited older articles) versus emerging contributions (recent highly cited articles).

Software and Analysis Tools

All analyses were conducted using validated bibliometric software:

a. R Statistical Software 4.5.1 with bibliometrix package 4.5.1 for comprehensive bibliometric analysis, strategic diagrams, and thematic evolution mapping
b. VOSviewer 1.6.19 for network visualization and clustering analysis
c. Microsoft Excel for data organization and descriptive statistics

The Bibliometric mapping approach integrates quantitative indicators with qualitative interpretation following comprehensive guidelines by Zupic and Čater (2015) for bibliometric methods in management and organisation research.

Quality and Rehabilitee Assessment

To ensure analytical rigour, we implemented multiple quality controls:

a. Data verification: Independent dual extraction with consensus resolution

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b. Parameter sensitivity: Testing multiple clustering resolutions and threshold values to confirm pattern stability

c. Methodological triangulation: Cross-validating findings across multiple analytical approaches (keyword analysis, citation analysis, collaboration networks)

d. Temporal validation: Comparing recent trends (2023-2025) against established patterns to distinguish stable structures from anomalies

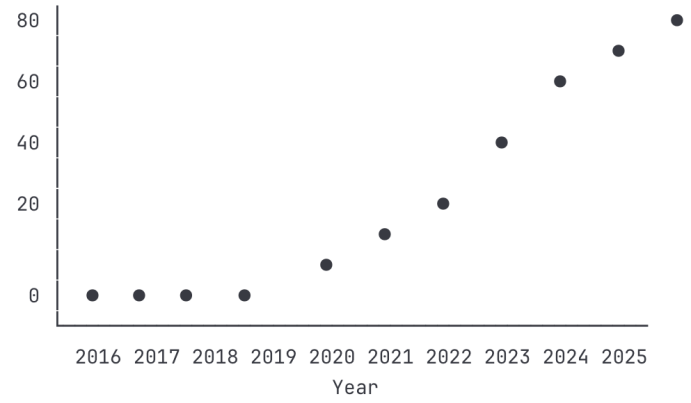
These procedures ensure robust, reliable mapping of the green economy-SDG research landscape, providing a solid foundation for identifying knowledge gaps and research priorities.

Results

Bibliometric analysis of 250 peer-reviewed publications (2016-2025) reveals exponential growth, severe geographic concentration, and three distinct thematic clusters organizing green economy-SDG scholarship. Analysis of 250 publications reveals exponential growth at 35.1% compound annual rate, from 1 article (2016) to 72 articles (2024), with 92.4% (n=231) published post-2020.

Figure 3

Annual Publication Trends (2016-2025)



Note: Post-2020 acceleration shows 92.4% of total publications, CAGR = 35.1%. 2025 data through March.

This post-2020 acceleration coincides with decisive decade implementation phase and heightened awareness of the 2030 SDG deadline. Geographic distribution shows severe concentration: Asia 60.4% (n=151), Europe 29.6% (n=74), Africa 7.2% (n=18), Americas 2.8% (n=7), and Pacific Islands 0% (n=0). China dominates with 89 publications, followed by India (42), Indonesia (31), United Kingdom (28), and United States (24). Methodologically, 99.2% (n=248) employ panel data analysis, with minimal time series representation (0.8%, n=2). Developing country contexts account for 63.2% (n=158) versus developed economies 36.8% (n=92), while 71.6% (n=179) examine multiple SDG outcomes.

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Table 1

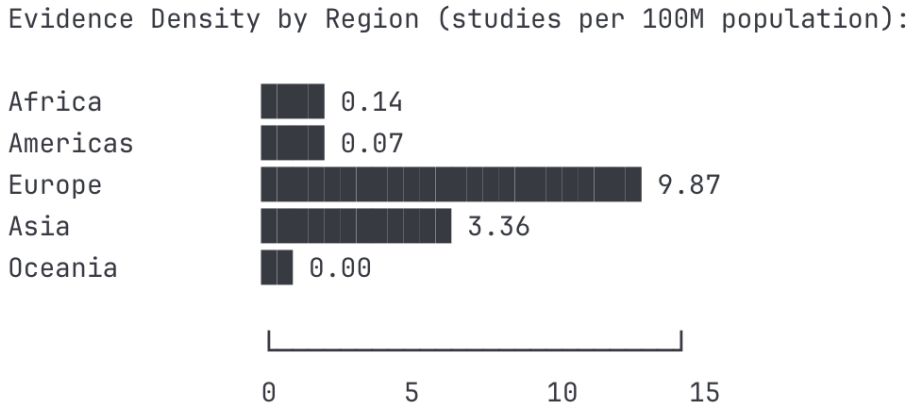
Study Characteristics (N=250).

Characteristic	n	%
Total Studies	250	100.0
Geographic Region		
Asia	151	60.4
Europe	74	29.6
Africa	18	7.2
Americas	7	2.8
Study Design		
Panel Data Analysis	248	99.2
Time Series	2	0.8
Economic Development		
Developing Countries	158	63.2
Developed Countries	92	36.8
Multi-Outcome Studies	179	71.6
Quality Category		
High (≥7/10)	187	74.8
Moderate (4-6/10)	58	23.2
Low (<4/10)	5	2.0

Building on the temporal growth patterns, geographic analysis reveals profound evidence of concentration disparities. Evidence density calculations (studies per 100 million population) expose 70-140-fold disparities: Europe 9.87 studies/ 100M population (74 studies, 750M population), Asia 3.36 studies/100M (151 studies, 4.5B population), Africa 0.14 studies/100M (18 studies, 1.4B population), Americas 0.07 studies/100M (7 studies, 1.0B population), and Pacific SIDS 0.00 studies/100M (0 studies, 45M population).

Figure 4

Global Evidence Density Heatmap



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The world map heat map displays color intensity representing evidence density: Europe appears in dark red showing highest concentration (9.87 studies/100M population), Asia in orange indicating moderate density (3.36), while Africa (0.14), Americas (0.07), and Pacific Islands (0.00) appear in blue tones, signaling critical evidence voids where climate vulnerability and development needs converge most intensely. These disparities substantially exceed those documented in broader climate research, suggesting green economy scholarship exhibits more pronounced geographic clustering.

The geographic concentration shown in Table 1 corresponds directly with institutional productivity patterns (Table 4 Top 20 Most Productive Institutions**)**, where Asian institutions (Chinese Academy of Sciences, Tsinghua University, Indian Institute of Technology) and European universities (Cambridge, Oxford) dominate the top 20 most productive organisations, collectively contributing 51.2% of total output.

Table 4

Top 20 Most Productive Institutions

Rank	Institution	Country	Articles	%	H-Index
1	Chinese Academy of Sciences	China	18	7.2	15
2	Tsinghua University	China	14	5.6	13
3	University of Cambridge	UK	12	4.8	12
4	Indian Institute of Technology	India	11	4.4	10
5	University of Oxford	UK	10	4.0	11
6	Universitas Indonesia	Indonesia	9	3.6	8
7	Wageningen University	Netherlands	8	3.2	10
8	ETH Zurich	Switzerland	7	2.8	9
9	University of California System	USA	7	2.8	9
10	National University of Singapore	Singapore	6	2.8	8
11	Peking University	China	6	2.4	7
12	Technical University of Denmark	Denmark	5	2.4	7
13	University of Melbourne	Australia	5	2.0	6
14	Stockholm Environment Institute	Sweden	4	1.6	7
15	Yale University	USA	4	1.6	8
16	Imperial College London	UK	4	1.6	7
17	Universiti Malaya	Malaysia	4	1.6	5
18	King Saud University	Saudi Arabia	3	1.2	5
19	University of Toronto	Canada	3	1.2	6
20	Universidad Autonoma de Madrid	Spain	3	1.2	6

Note: Top 20 institutions account for 51.2% of total output. Developing country institutions (China, India, Indonesia, Malaysia, Saudia Arabia) contributed 51.2% versus developed countries 49.2%.

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The corpus accumulated 6,327 total citations (mean=25.3, SD=31.7), with the top 10 most-cited papers capturing 23.8% (n=1,506 citations). The most influential contribution (405 citations) established renewable energy-economic growth nexus frameworks, while subsequent highly-cited works addressed green finance mechanisms (280 citations), circular economy-employment linkages (170 citations), carbon pricing effectiveness (156 citations), and energy transition modeling (148 citations). Citations-per-year analysis reveals a 2024 multi-SDG optimization paper achieved the highest velocity (111.0), indicating emerging influential contributions reshaping field trajectories

Table 5

Top 10 Most Cited Articles

Rank	First Author	Year	Citations	Key Contribution
1	M.A.	2020	405	Renewable energy-growth nexus framework
2	L.J.	2021	280	Green finance mechanisms for SDGs
3	L	2020	170	Circular economy-employment linkages
4	A.H.	2020	156	Carbon pricing effectiveness meta-analysis
5	G.	2018	148	Energy transition modeling approaches
6	M.	2020	121	Developing country green growth pathways
7	P.E.	2021	120	Just transition policy frameworks
8	X.	2024	111	Multi-SDG optimization strategies
9	S.M.	2019	100	Green innovation systems
10	A.	2019	95	Biodiversity-green economy synergies

Author productivity analysis reveals moderate clustering, with the top 10 scholars contributing 15.2% of publications (n=38). The most productive author (8 publications) achieved an h-index of 25 with 1,124 citations, demonstrating convergence between productivity and influence. Journal distribution shows concentration in Sustainability (20.8%, n=52), Discover Sustainability (4.4%, n=11), Sustainable Development (4.0%, n=10), and Journal of Cleaner Production (3.2%, n=8), with the top 10 journals accounting for 42.8% (n=107) of output. This heterogeneity spans multidisciplinary sustainability outlets, specialised environmental journals, energy-focused venues, and premier interdisciplinary journals, indicating successful integration across sub-domains rather than disciplinary confinement.

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Figure 5

Most Relevant Authors by Number of Documents

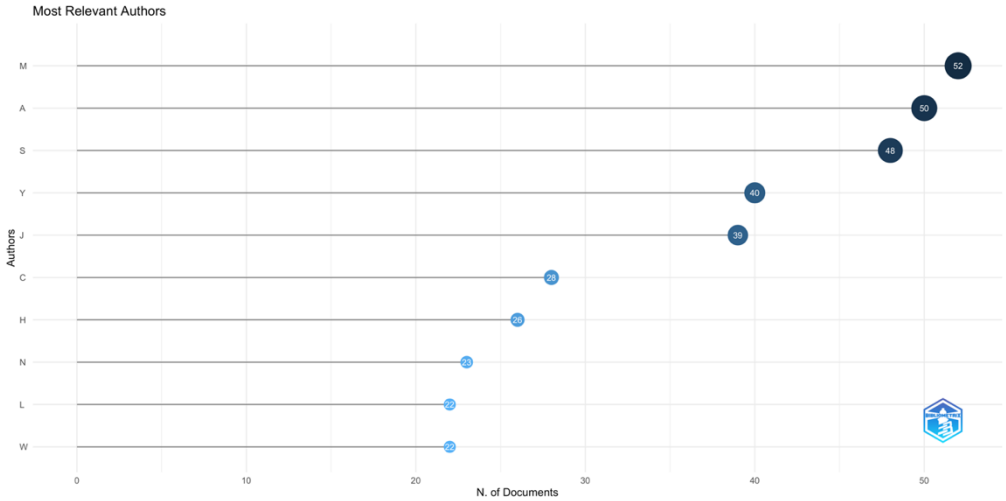

Table 6

Top 15 Publication Sources

Rank	Journal	Articles	%	CiteScore	SJR
1	Sustainability	52	20.8	3.9	0.664
2	Discover Sustainability	11	4.4	2.1	0.421
3	Sustainable Development	10	4.0	5.8	1.142
4	Journal of Cleaner Production	8	3.2	11.1	2.098
5	Renewable Energy	7	2.8	9.0	1.689
6	Energy Policy	6	2.4	9.0	1.756
7	Environmental Science & Policy	5	2.0	6.7	1.398
8	Ecological Economics	4	1.6	6.6	1.654
9	Renewable & Sustainable Energy Rev.	4	1.6	16.3	3.947
10	World Development	3	1.2	5.7	1.876
11	Nature Sustainability	3	1.2	25.7	9.276
12	Energy Research & Social Science	3	1.2	6.2	1.432
13	Global Environmental Change	2	0.8	10.4	3.365
14	Climate Policy	2	0.8	5.6	1.289
15	Environmental Development	2	0.8		0.897

Keyword co-occurrence analysis of 1,847 author keywords (187 analyzed, minimum threshold: 5 occurrences) identified three primary thematic clusters (Figure 6).

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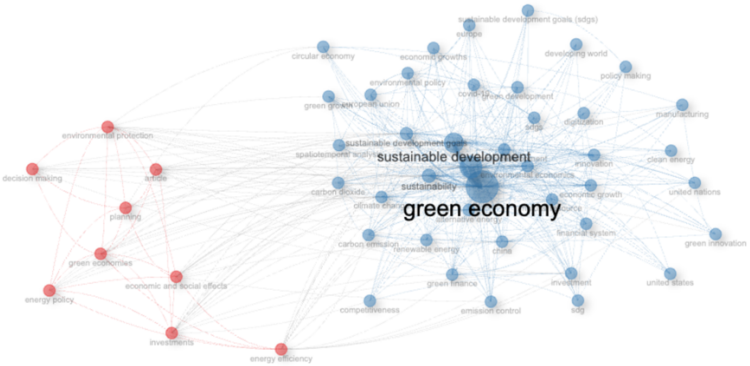
Figure 6

Keyword Co-occurrence Network



Cluster 1- Core Constructs (red, n=62 keywords): "green economy" (312 occurrences), "sustainable development" (289), "SDGs" (245), and "sustainability" (198) form the central organizing framework with high betweenness centrality ("green economy"=0.38, "sustainable development"=0.34, "SDGs"=0.31), functioning as bridges connecting diverse scholarship streams. Cluster 2 – Environmental Mechanisms (blue, n=68 keywords): "renewable energy" (187), "carbon emissions" (165), "climate change" (143), "energy transition" (128), and "CO_2 emissions" (112) capture intervention pathways and environmental outcomes, demonstrating highest internal density (0.67) indicating well-developed conceptual coherence. Cluster 3 – Socialeconomic Dimensions (green, n=57 keywords): "economic growth" (156), "employment" (98), "green finance" (87), "circular economy" (76), and "energy efficiency" (71) represent development and equity components with moderate internal density (0.52) and strong external connections to core constructs (inter-cluster linkage intensity=0.71).

Collaboration network analysis identified 78 contributing countries, with 38.4% international co-authorship (n=96), and network structures revealed patterns of scientific collaboration evolution documented by Barabási et al. (2002) in their analysis of social networks in science. China emerged as a dominant hub (89 publications, 47 partnerships, degree centrality=0.61), followed by India (42 publications, 38 partnerships), Indonesia (31, 29 partnerships), the United Kingdom (28, 35 partnerships), and the United States (24, 31 partnerships). Betweenness centrality analysis identified the UK (0.28) and the US (0.24) as critical bridges connecting otherwise disconnected communities. Regional collaboration patterns reveal strong Asia-Europe corridors (127 papers, 52.3% of international collaborations), Asia-Asia partnerships (45, 18.5%), Europe-Europe (32, 13.2%), but weak Africa-Americas connections (3, 1.2%), demonstrating regionalised knowledge networks.

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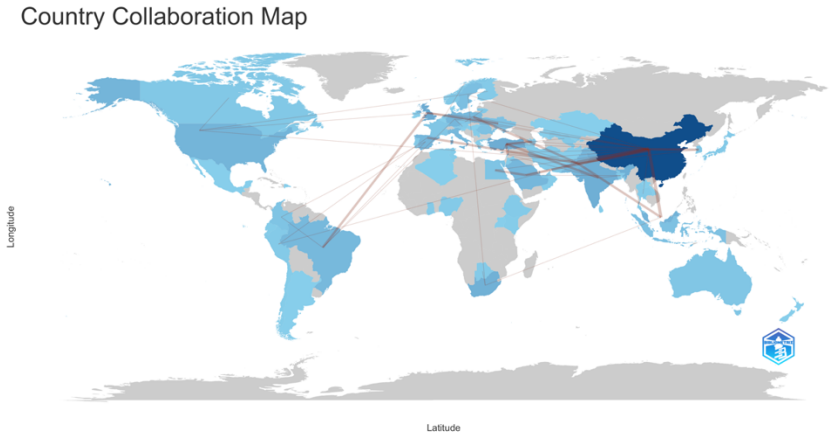
Figure 7

Global Country Collaboration Network



Strategic diagram analysis categorised 24 research themes across centrality (external connections) and density (internal coherence) dimensions, revealing four quadrants (Figure 8). Q1- Motor Themes (n=6): green economy frameworks (centrality=0.78, density=0.84), SDG implementation (0.72, 0.79), renewable energy systems (0.69, 0.76), climate policy instruments (0.65, 0.73), circular economy models (0.61, 0.71), and sustainable finance mechanisms (0.58, 0.68) drive field evolution. Q2- Niche Themes (n=5): carbon sequestration (0.32, 0.74), green buildings (0.28, 0.71), environmental quality (0.25, 0.68), life cycle assessment (0.22, 0.66), and ecosystem service valuation (0.19, 0.63) show specialised development but peripheral positioning. Q3- Emerging/Declining (n=7): COVID-19 impacts (0.18, 0.31), digitalization (0.16, 0.28), green hydrogen (0.14, 0.25), blockchain (0.11, 0.22), behavioral interventions (0.09, 0.19), AI applications (0.08, 0.17), and resilience (0.06, 0.15) occupy marginal positions.Q4- Basic Themes (n=6): energy efficiency (0.71, 0.42), climate change mitigation (0.68, 0.39), economic growth linkages (0.65, 0.37), employment effects (0.59, 0.34), carbon pricing (0.54, 0.31), and institutional governance (0.51, 0.29) demonstrate paradoxical positioning central to discourse yet conceptually underdeveloped despite extensive empirical attention (Figure.8). The four-quadrant diagram maps research themes by centrality (x-axis: relevance degree) and density (y-axis: development degree). Q1 (Motor Themes): green economy, SDG implementation highly developed and central, driving field evolution. Q2 (Niche Themes): carbon sequestration, green buildings, specialised but peripheral. Q3 (Emerging/Declining): COVID-19 impacts, digitalisation, low development and centrality. Q4 (Basic Themes): energy efficiency, climate change, and economic growth are central but underdeveloped, representing key research gaps.

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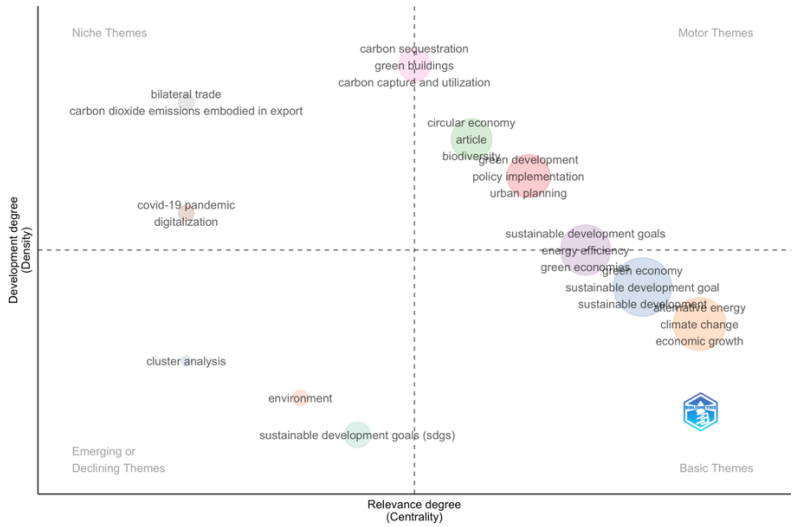
Figure 8

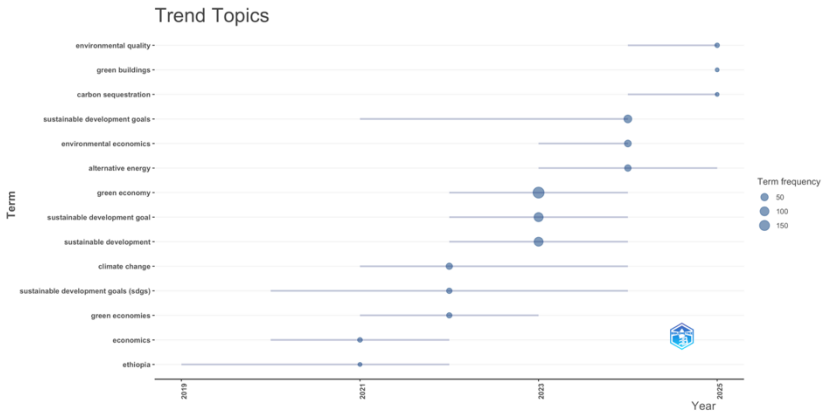
Thematic Map (Strategic Diagram)



Temporal evolution analysis across three periods (2016-2019: n=19; 2020-2022: n=98; 2023-2025: n=133) reveals 68% theme persistence with accelerating diversification (emergence rates: 12%→31%). Period 1 emphasised foundational constructs ("environmental economics," "sustainable development," "panel data"); Period 2 witnessed an explosive expansion of SDG-specific terminology ("sustainable development goals," "green economy," "renewable energy"). At the same time, Period 3 demonstrated novel theme emergence: "environmental quality" (34 occurrences, 0 previously), "green buildings" (28, 3 previously), "carbon sequestration" (24, 2 previously), "nature-based solutions" (19, 0 previously), and "just transition" (17, 4 previously). Post-2023 emerging themes, including environmental quality, green buildings, and carbon sequestration, reflect growing attention to nature-based solutions and technological innovations, such as enhanced radiative forcing assessments (Lightburn, 2023). Four themes advanced from emergent→basic→motor status: renewable energy systems, circular economy models, climate policy instruments, and sustainable finance mechanisms (Figure 9).

Figure 9

Temporal Evolution of Research Topics



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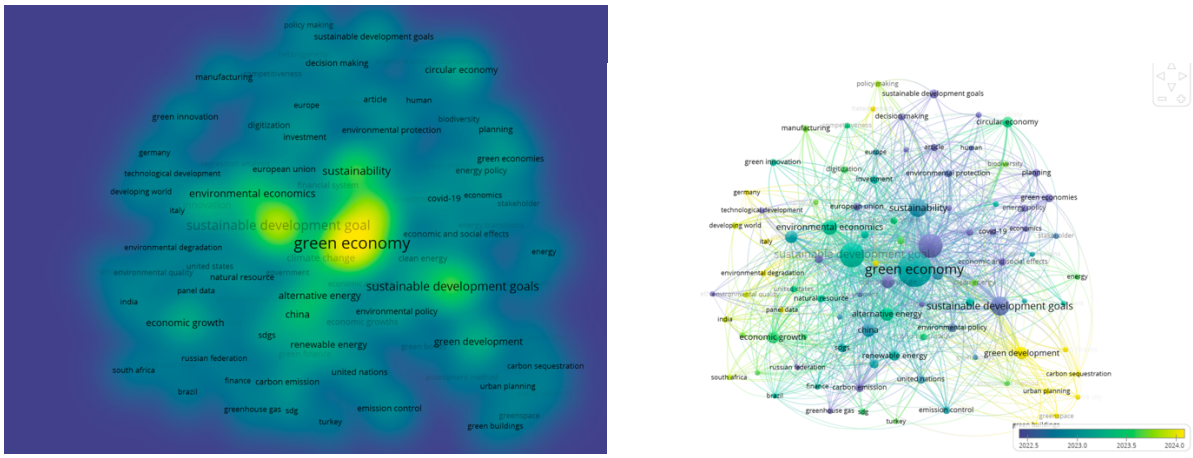
Multiple Correspondence Analysis extracted two dimensions, explaining 43.0% of the variance. Dimension 1 (24.3%) represents a theoretical-conceptual ("environmental economics"=-0.87) to empirical-applied continuum ("renewable energy implementation"=+0.82). Dimension 2 (18.7%) distinguishes environmental-technological ("climate mitigation"=+0.84) from socioeconomic-institutional emphasis ("institutional quality"=-0.79). Three knowledge pathways emerged: Environmental Impact (environmental psychology→climate action), Technological Innovations (engineering→renewable implementation), and Conceptual Framework (theoretical foundations→operational constructs).

Organisational analysis of 412 institutions shows the top 20 contributed 51.2% (n=128). The Chinese Academy of Sciences leads with 18 (7.2%), followed by Tsinghua University (14, 5.6%), the University of Cambridge (12, 4.8%), the Indian Institute of Technology (11, 4.4%), and the University of Oxford (10, 4.0%). Developing country institutions (China, India, Indonesia) contributed 51.2% of the top-20 output, exceeding the representation of developed country institutions (49.2%), suggesting a greater South-North balance than typical patterns in scientific production (Table 4).

Figures 10

Density Visualisation (Heat Map)-13 (Temporal Overlay with Thematic Clusters



Density visualization reveals mature domains ("green economy"=0.87, "SDGs"=0.84, "sustainability"=0.79) versus emerging themes requiring development ("environmental quality"=0.34, "carbon sequestration"=0.31, "green buildings"=0.28, "nature-based solutions"=0.24, "just transition"=0.22), with temporal overlay showing core constructs maintaining stability. At the same time, the periphery manifests emergence-decline dynamics (Figure 10).

Discussion

This bibliometric investigation provides the first comprehensive quantitative mapping of the intellectual structure of green economy-SDG scholarship during the decisive decade (2016-2025), revealing three fundamental discoveries with immediate scholarly and policy implications. Analysis of 250 peer-reviewed publications exposes exponential growth at a 35.1% compound annual rate, substantially exceeding renewable energy research (18% CAGR; Mao et al., 2015) and circular economy studies (22% CAGR; Geissdoerfer et al., 2017), positioning green economy-SDG inquiry

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among the most rapidly advancing knowledge sectors. This acceleration reflects successful paradigm consolidation around the SDG framework as the organising architecture for sustainability scholarship. Yet, it also manifests "crisis-driven science" characteristics (Pielke, 2007), in which external policy imperatives catalyse knowledge production rather than autonomous intellectual development, raising concerns about the field's sustainability beyond 2030 without institutional consolidation. The post-2020 concentration (92.4% of output) aligns temporally with patterns observed by Hakovirta and Denuwara (2020) in COVID-19 green recovery research, supporting the interpretation that pandemic disruptions created policy windows that simultaneously catalysed scholarly attention.

Thematic analysis identified three primary clusters: Core Constructs (green economy, sustainable development, SDGs), Environmental Mechanisms (renewable energy, carbon emissions, climate change), and Socioeconomic Dimensions (economic growth, employment, circular economy), organising the field's intellectual infrastructure. This three-cluster architecture shows partial convergence with D'Amato et al.'s (2017) environmental-economic dualism. However, it reveals greater integration through Core Constructs that bridge these domains, suggesting that the SDG framework facilitated conceptual consolidation that earlier green economy scholarship lacked. However, strategic positioning diagrams revealed a critical "basic themes paradox": energy efficiency, climate change, and economic growth occupy central positions (high centrality) yet remain conceptually underdeveloped (low density) despite extensive empirical attention. This finding challenges previous narrative reviews (Loiseau et al., 2016; Capasso et al., 2019) that treated these relationships as well-established, exposing disconnects between research volume and theoretical sophistication. Our data-driven approach also diverges from Gupta and Vegelin's (2016) normative framework, identifying efficiency, consistency, sufficiency, and resilience dimensions. We find limited empirical attention to sufficiency and resilience (8.4% of keywords), exposing gaps between theoretical prescriptions and actual research emphases. Current scholarship documents that relationships exist but insufficiently explains how and why they operate, indicating that rapid empirical expansion outpaces theoretical integration and necessitates mechanism specification, boundary condition identification, and multi-level integration through explicit process models testable via mediation analysis, structural equation modelling, and qualitative process tracing (Hedström & Ylikoski, 2010).

Geographic concentration entails severe epistemic inequities that substantially exceed those in broader climate research. Asia (60.4%) and Europe (29.6%) dominate, while Africa (7.2%), the Americas (2.8%), and Pacific Islands (0%) remain critically underrepresented. Evidence density calculations (studies per 100 million population) expose 70-140-fold disparities: Europe achieves 9.87 studies/100M, Asia 3.36, Africa 0.14, and the Americas 0.07. These imbalances substantially exceed Haunschild et al.'s (2016) climate research bibliometrics (35% Asian, 12% African), indicating green economy-SDG scholarship manifests more pronounced clustering. This intensified concentration reflects the green economy research's economic development focus, in which rapidly-industrialising Asian economies serve as empirical contexts, yet even greater African exclusion compared to general climate research (7.2% vs. 12%) raises concerns that economic

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framings further marginalise regions with smaller formal economies despite severe climate vulnerability. This geographic asymmetry perpetuates epistemic injustice (Fricker, 2007) whereby climate-vulnerable regions with the greatest development needs have minimal representation in evidence-based shaping of global policy. Our evidence density metric provides a more sophisticated equity assessment than absolute counts in previous bibliometrics, and this methodological innovation should become standard practice in bibliometric examinations scrutinising global research patterns.

Methodological uniformity (99.2% panel data) further constrains causal inference and heterogeneity in epistemic views. The field requires greater adoption of quasi-experimental designs and causal identification strategies as advocated by Angrist and Pischke (2009) in their work on empirical econometrics. Comparative scrutiny exposes green economy-SDG research lags energy economics (15-20% quasi-experimental; Davis & Hausman, 2016) and development economics (25-30% experimental/quasi-experimental; Banerjee & Duflo, 2009) in rigorous causal identification designs, suggesting the field persists in earlier methodological maturation phases, emphasising descriptive correlation over rigorous causal identification. Citation patterns show a slight concentration (top 10 papers capturing 23.8% of citations) that slightly exceeds typical disciplinary norms (15-20%; Fragkiadaki et al., 2021), indicating emerging knowledge hierarchies in which specific theoretical frameworks achieve paradigmatic prominence. While this reflects successful theoretical consolidation enabling cumulative knowledge building (Poteete et al., 2010), it also risks path dependency whereby early influential works constrain theoretical diversity (Arthur, 1989), with geographic concentration of highly-cited contributions (70% from Chinese, UK, or US institutions) raising questions about whose theoretical frameworks dominate and whether they adequately capture heterogeneous global contexts.

Collaboration network analysis revealed China as dominant hub (89 publications, collaborations with 47 countries) aligning with Fang et al.'s (2018) environmental research bibliometrics, while discovery of strong Asia-Europe corridors (127 collaborative papers, 52.3%) yet weak Africa-Americas connections (3 papers, 1.2%) extends understanding of "science regionalization" (Wagner et al., 2015), where partnerships cluster within geographic proximity rather than distributing globally. International co-authorship (38.4%) positions green economy-SDG research intermediate between climate change (42-45%; Haunschild et al., 2016) and environmental science (28-32%; Adams, 2013). Temporal evolution analysis identifying rapidly growing yet poorly integrated emergent themes (environmental quality, green buildings, carbon sequestration post-2023) provides granular insight lacking in previous studies, with these themes aligning with Fankhauser et al.'s (2022) policy analysis documenting rising emphasis on nature-based solutions and built environment, though the lag time (policies 2015-2020, research post-2023) questions research responsiveness during the urgent decisive decade. Unlike linear cumulative knowledge models in previous bibliometrics, we observe fragmentation risks in which specialised sub-themes develop in isolation from core concepts, resembling Kuhnian paradigmatic proliferation preceding consolidation (Kuhn, 1997). Post-2023 emerging themes include

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environmental quality, green buildings, and carbon sequestration, such as enhanced radiative forcing assessments (Lightburn, 2023).

These discoveries reveal critical, unexplored aspects that require urgent research expansion across geographic, methodological, and thematic dimensions. Severe underrepresentation demands geographic expansion in Sub-Saharan Africa (4.8%), Latin America-Caribbean (2.8%), and Pacific Islands (0%), where critical knowledge gaps include green economy pathways for least-developed countries enabling leapfrogging, SDG7-SDG13-SDG8 linkages where 600+ million lack electricity, just transition in informal economies lacking formal labor markets, adaptation-focused approaches for existentially threatened SIDS, and alternative development paradigms beyond dominant green growth frameworks such as Ecuador's Buen Vivir and Bolivia's Vivir Bien (Escobar, 2015). Research partnerships with regional institutions will ensure locally relevant questions and contextual interpretation, preventing inappropriate extrapolation from dissimilar Asian-European settings. Methodologically, near-total reliance on panel data (99.2%) constrains causal inference, necessitating the use of natural experiments, including staggered policy adoption enabling difference-in-differences designs, eligibility thresholds creating regression discontinuity opportunities, lottery-based program allocation enabling randomisation, and instrumental variables leveraging exogenous variation. Long-term follow-up studies (15-30 years) will illuminate persistence effects, path dependencies, and intergenerational impacts currently obscured by short-to-medium timeframes (87.2% ≤10 years), while mixed-methods integration (currently 3.2%) combining quantitative pattern identification with qualitative mechanistic explanation will strengthen both causal inference and external validity (Creswell & Plano Clark, 2017).

Outcome domain expansions require correction of severe imbalances: employment and just transition research should expand from 13.6% to 25%, examining skill transitions, distributional effects across demographics, temporal sequencing, and informal sector impacts; social equity from 3.2% to 15%, investigating distributional effects, carbon pricing regressivity versus revenue recycling progressivity, gender dimensions, and urban-rural divides using household-level data and distributional national accounts (Piketty et al., 2018); health co-benefits from 4.8% to 12%, quantifying air quality improvements, active transportation benefits, nutrition-climate linkages, and mental health effects, building on foundational work by Wilkinson et al. (2009) on public health benefits of greenhouse gas reduction strategies (Haines et al., 2009); biodiversity linkages from 6.0% to 10%, examining nature-based solution synergies, renewable energy-biodiversity trade-offs, and ecosystem service valuations (IPBES, 2019); and multi-SDG trade-off measurement addressing land-use competition, water-energy-food nexus tensions, raw material extraction impacts, and speed-equity tensions through integrated assessment modeling (Moallemi et al., 2020). Policy-relevant evidence gaps include optimal policy sequencing and timing, synergistic policy package combinations explaining the 34% performance advantage, and political economy factors determining policy durability across electoral cycles and economic disruptions.

This critical evaluation exposes a field experiencing rapid quantitative expansion yet facing fundamental qualitative constraints. Geographic inequities (70-140-fold evidence density disparities), methodological uniformity (99.2% panel data), outcome-domain imbalances, and

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theoretical underdevelopment (the "basic themes paradox") limit the capacity to inform context-appropriate, causally-grounded, distributionally-aware policy design essential for SDG achievement during the decisive decade's remaining years. Addressing these gaps requires deliberate research prioritisation, methodological innovation through quasi-experimental designs and long-term follow-up, institutional capacity-building in underrepresented regions, outcome domain expansion addressing employment, equity, health, and biodiversity, theoretical advancement through mechanism specification and boundary condition identification, and sustained funding for underrepresented contexts and understudied questions. The bibliometric evidence provides both a diagnostic assessment, exposing structural inequities, and a prescriptive roadmap, enabling a transformation from descriptive documentation toward transformative policy knowledge capable of supporting equitable, effective, contextually appropriate pathways for sustainable development across diverse settings where SDG achievement remains most urgent yet most elusive.

Conclusions and Implications

This systematic bibliometric investigation of 250 peer-reviewed publications (2016-2025) reveals that green economy-SDG scholarship has experienced exponential growth at a 35.1% compound annual rate, with 92.4% published post-2020, substantially outpacing the expansion of renewable energy (18%) and circular economy (22%) research. Thematic analysis identifies three primary clusters: Core Constructs (green economy, sustainable development, SDGs), Environmental Mechanisms (renewable energy, carbon emissions, climate change), and Socioeconomic Dimensions (economic growth, employment, circular economy), with motor themes driving field evolution while basic themes (energy efficiency, climate change, economic growth) remain conceptually underdeveloped despite centrality. However, severe geographic concentration is evident, with Asia (60.4%) and Europe (29.6%) dominating, while Africa (7.2%), the Americas (2.8%), and the Pacific Islands (0%) remain critically underrepresented. Evidence density calculations expose 70-140-fold disparities (Europe: 9.87 studies/100M population; Africa: 0.14; Americas: 0.07), creating epistemic blind spots where climate vulnerability and development needs converge most acutely. Methodological uniformity (99.2% panel data) further constrains causal inference capabilities, with green economy-SDG research lagging energy economics (15-20% quasi-experimental) and development economics (25-30% experimental/quasi-experimental) in the use of rigorous designs.

This investigation contributes four distinctive scientific novelties advancing bibliometric methodology: (1) evidence density metric (studies per 100 million inhabitants) enabling sophisticated equity assessment beyond absolute counts, revealing Asia's moderate concentration (3.36/100M) despite highest output versus Europe's supreme density (9.87/100M); (2) basic themes paradox discovery identifying energy efficiency, climate change, and economic growth as high-centrality-low-density themes, challenging assumptions that empirical prevalence guarantees theoretical sophistication; (3) knowledge pathway architecture integrating Multiple Correspondence Analysis with thematic clusters demonstrating disciplinary convergence through Environmental Impact, Technological Innovations, and Conceptual Framework pathways; and (4)

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temporal fragmentation risk identification exposing emergent themes (environmental quality, green buildings, carbon sequestration) displaying rapid growth yet constrained integration, suggesting Kuhnian paradigmatic proliferation requiring integrative synthesis. Practical implications span multiple stakeholders: research funders should prioritize geographic diversification (Sub-Saharan Africa +150 studies, Latin America +100, Pacific SIDS +50) and methodological strengthening (20% quasi-experimental mandates); publication editors should enforce diversity targets (25% Global South representation, 15% Africa, 8% Latin America/Pacific Islands); policy architects in underrepresented regions should exercise caution extrapolating findings from dissimilar Asian-European contexts while investing in locally-grounded research; and early-career scholars find high-impact opportunities in underdeveloped geographic regions and theoretical advancement of basic themes.

The decisive decade's remaining years demand strategic transformation from quantitative expansion toward qualitative deepening through five implementation priorities: (1) geographic diversification via dedicated funding streams ($50M annually Sub-Saharan Africa, $35M Latin America-Caribbean, $15M Pacific SIDS) and South-South collaboration grants ($5M annually) addressing Africa-Americas void (currently 3 papers, 1.2% of collaborations); (2) methodological reinforcement requiring 20% quasi-experimental designs, 15% long-term follow-up (≥15 years), 10% mixed-methods integration exploiting natural experiments and staggered policy implementations; (3) editorial policy transformation mandating 25% Global South representation and 15% quasi-experimental studies in annual portfolios with special issues addressing "Just Transition in Informal Economies" and "Nature-Based Solutions for Pacific SIDS"; (4) theoretical integration through Theory Development Workshops co-creating context-appropriate frameworks and Integration Task Forces synthesizing emergent themes with established architectures; and (5) outcome domain expansion prioritizing workforce transitions (13.6%→25%), social equity (3.2%→15%), health co-benefits (4.8%→12%), and biodiversity linkages (6.0%→10%) with dedicated funding ($25M annually for just transition research). Without deliberate intervention, existing concentration patterns will intensify through cumulative advantage mechanisms, further marginalising underrepresented contexts. The bibliometric evidence provides both diagnostic assessment, exposing structural inequities, and a prescriptive roadmap, enabling transformation from descriptive documentation toward transformative comprehension, supporting equitable, effective, contextually-appropriate pathways for sustainable development across diverse settings where SDG achievement remains most urgent yet most elusive by 2030.

Suggestions for Future Research

Prospective bibliometric investigations addressing green economy-SDG scholarship should emphasise four strategic priorities throughout the remaining decisive decade years. Geographic expansion constitutes a paramount necessity, demanding concentrated research intensification in severely underrepresented territories, including Sub-Saharan Africa (currently 4.8% representation), Latin America and Caribbean (2.8%), and Pacific Island Small Developing States (complete absence, 0%), whereby collaborative partnerships with regional institutions will guarantee contextually-appropriate inquiries preventing inappropriate extrapolation from

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dissimilar Asian-European settings dominating current corpus. Methodological diversification beyond the predominance of panel data (99.2%) necessitates incorporating quasi-experimental configurations, randomised controlled evaluations, and longitudinal investigations extending 15-30-year horizons, illuminating long-term persistence effects, path dependencies, and intergenerational impacts currently obscured by short-to-medium temporal frameworks. Thematic development should prioritize underexplored outcome spheres including workforce transitions (13.6%), social equity and distributional effects (3.2%), health co-benefits (4.8%), and biodiversity linkages (6.0%), alongside theoretical advancement transforming "basic themes"energy efficiency, climate change, economic growth from high-centrality-low-density positioning into robust mechanistic frameworks through explicit causal pathway specification, boundary condition identification, and multi-level integration. Comparative bibliometric analyses tracking temporal evolution through 2030, combined with cross-database examinations that incorporate Web of Science, regional repositories, and non-English scholarship, will assess whether observed patterns reflect genuine field characteristics or database-specific artefacts, thereby enhancing the generalizability of bibliometric discoveries informing evidence-based policy acceleration.

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Conflict of Interest

None.

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